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fees) has been paid into the treasury, and the remaining three thousand dollars has been properly secured.

The Committee of Conference appointed to confer with a committee of the Academy of Natural Sciences of Philadelphia, was on motion discharged from further consideration of the subject, inasmuch as the committee of the Academy had been previously discharged.

On motion of Dr. Le Conte the Secretaries were authorized to procure a suitable album for preserving the photographs of the members.

And the Society was adjourned.

Stated Meeting, May 18, 1866.

Present, sixteen members.

Prof. CRESSON, Vice-President, in the Chair.

A letter accepting membership was received from Dr. Pliny Earle, dated Northampton, May 5th, 1866.

Letters of invoice were received from the Holland Society at Haarlem, and Prof. J. D. Whitney, San Francisco, April 16th, 1866.

Photographs of Thomas U. Walter, Dr. John Morgan, and Mr. Robert Briggs, were presented for insertion in the Album. The photograph of Dr. Morgan was from J. R. Lambden's copy of a portrait by Angelica Kauffmann.

Donations for the Library were received from the Geographical Societies at St. Petersburg and Paris, the Academy at Berlin, Prof. Zantedeschi, the Observatory of San Fernando, the Society of Sciences at Haarlem, the Boston Natural History Society, the Editors of the American Journal of Science, the Franklin Institute, Smithsonian Institution, Prof. J. C. Cresson, Prof. J. D. Whitney, and various booksellers.

A communication was offered for publication in the Transactions, entitled "On Fucoids in the Coal," by Leo Lesque-

reux, which was referred to a committee consisting of Mr. Lea, Mr. T. P. James, and Mr. Lesley.

A communication was offered for publication in the Transactions, entitled "The Law in the Forms of Continents and Oceans," by O. Reichenbach, which on motion was referred to a committee consisting of Prof. Cresson, Prof. Kendall, and Prof. Hayden.

The Secretary then read a communication entitled: "Observations upon some species of *Spirifera*, being the concluding remarks of the chapter on the descriptions of species of that genus from the upper Helderberg, Hamilton and Chemung groups." (From the Palæontology of New York, vol. iv, pp. 252-257; unpublished.) By James Hall.

Some important considerations are suggested by the study of *Spirifera præmatura*, *Spirifera alta*, and their associates.

The species which I have here designated as *Spirifera præmatura* presents no external markings which enable one to say that it is distinct from *S. hirtus* of the sandstones at Burlington, Iowa; nor does it present differences from *S. pseudolineata* which may not be reconciled with geographical influences, and with a habitat nearer to the shore line and the essential absence of calcareous matter in the sediments deposited. Its associates, however, are of different species from those in the western locality; but still among the more conspicuous of these is *Spirifera alta*, *Productus lachrymosa* var., and *Chonetes muricata*, which have a carboniferous aspect; and were it not for the presence of *Spirifera disjuncta* and one or two others, the general aspect of the fauna might be termed carboniferous.

If again we look at the characters of *Spirifera alta*, an analogue or representative of *Spirifera cuspidata*, we have many points of similarity with one or more species in the rocks of the West and Southwest which are usually referred to a higher position. The high area and the transverse concave septum, which is not a true pseudo-deltidium, allies it with *Spirifera textus*, in which we find similar features. In the *S. alta* there has probably been an external convex pseudo-deltidium, and between this and the septum closing the fissure there has been a narrow space. This septum, which is an extension of the dental lamellæ, has been thickened or expanded on the inner side, as shown by the casts of the ventral valve; and in several specimens there is a narrow semi-cylindrical depression extending nearly to the beak of the valve.

In comparing this species with *Spirifera textus*, we find similar conditions, or more properly an extension or amplification of the same features. In that species there is a convex arching pseudo-deltidium, though rarely preserved in the specimens. Beneath this there is a concave septum, and upon the inner face of this there is a tubular callosity; or, in other words, the inner laminæ of the septum become fistulous, and inclose a cylindrical or subcylindrical space, which extends from the base of the septum to near the apex of the valve.* But more usually the laminæ appear to be separated, and extending inwards are recurved, their edges sometimes joining to form a tube, but more frequently perhaps the margin of each one is recurved upon itself, leaving the tube with a slit along the lower side. In some instances, however, these extensions from the inner face of the septum continue to the bottom of the cavity, and joining the external shell leave a quadrangular tube instead of a cylindrical one.

It is evident from what has been said, as well as from the illustrations given, that there is a near approach to this character of *S. textus*, or an incipient step towards it, in *Spirifera alta*; but the type has not become fully developed. We have the concave septum with a semicylindrical callosity on its inner face, but this ridge has apparently remained solid. The concave septum, however, must not be confounded with the pseudo-deltidium: the latter is apparently an independent growth of shelly (or sometimes perhaps scarcely solid shell) matter, forming an exterior plate from the apex of the fissure, covering to a greater or less extent the opening; but apparently not connected with, nor a part of the dental lamellæ or substance of the area, while the septum is an outgrowth or lateral extension of the dental plates.

In the case of *Spirifera alta*, the extension of the septum is so great, that when connected with the general form of the shell, its nearest analogue appears to be *Spirifera textus*; which, so far as I can now determine, is identical with the one described as *S. subcuspidatus* in the Geological Report of Iowa. The latter is a carboniferous species from the Keokuk limestone, and closely allied to the *Spirifera cuspidatus* of Europe; and the Chemung species thus reminds us of the Carboniferous one, or has a carboniferous aspect.

If, in its full development, the presence of a septum and internal tube be regarded as of generic value, then we have in *Spirifera alta*

* It is upon this feature, or one of similar character, in its full development, that I understand Prof. Winchell proposes to found the Genus *Syringothyris*.

the same appendages in part, or in a partially developed condition; the distinct tube only being wanting. But had we the means of examining the internal characters of the ventral valves of all the species of Spirifers, we should probably find graduations from the solid filling of the rostral cavity, with a greater or less extension of shelly matter in the form of a septum in the fissure occupying a narrow space in its apex, till we reach the development observed in *S. alta* and *S. textus*.

To a considerable extent, we are able to prove this supposition. In the separated valves of *Spirifera radiata* of the Clinton and Niagara groups, there is a filling of the rostral cavity, and a thickening of the dental lamellæ which are extended for half the length of the valve. The narrow median crest of the muscular impression is expanded and thickened towards the apex of the valve, but there is no evidence of a septum. In *Spirifera niagarensis* there is a filling of the rostral cavity and a thickening of the dental lamellæ, which are distinctly separate; but no appearance of a septum: there is a low median crest in the muscular impression.

In the Lower Helderberg group, the *Spirifera macropleura* has the rostral cavity filled to a greater or less extent, and the dental plates extremely thickened at their bases; while there is an obscure low median crest in the muscular impression, which sometimes becomes thickened and expanded above; and occasionally there is a little filling of the upper part of the fissure, resembling the incipient stages of growth of the septum. In *Spirifera cycloptera* the rostral cavity is more or less filled and solid, with diverging dental lamellæ; while the crest dividing the muscular impression is very unequally developed, and there is no appearance of a septum. In *Spirifera perlamellosa* the rostral cavity is filled to a greater or less degree, the dental lamellæ are short and strong, and there is a sharp elevated median crest or septum in the muscular impression; but there is no indication of the transverse septum. In *Spirifera octocostata* the dental lamellæ are thickened, and there is a vertical septum reaching from the apex of the rostral cavity to the base of the muscular impression. In *Spirifera marylandica* of the Oriskany sandstone, there is sometimes a partial filling of the rostral cavity, with a reversed conical crest in the upper part of the muscular area. *Spirifera arenosa* has strong dental lamellæ; a filling of the rostral cavity in old shells; a low crest, dividing the muscular impression, which becomes thickened in its upper part; a distinct pseudo-deltidial covering of the fissure, but no transverse septum.

Among the Spirifers of the Upper Helderberg group, *Spirifera acuminata* has usually only a moderate thickening of the rostral portions, divergent lamellæ of moderate strength, and no transverse septum. In *Spirifera oweni* the rostral cavity is partially filled; the dental lamellæ are thickened; there is a reversed conical callosity at the apex of the cavity, the attenuated continuation of which divides the muscular area: the fissure is closed by a thickened plate or septum for one-half its length from the apex. In *Spirifera raricosta* the rostral cavity is filled; the dental lamellæ are short and thick; the fissure is closed by a solid filling for a part of its length, while from the bottom of the cavity there rises a thin vertical septum which extends to within one-third the length of the front of the valve. In *Spirifera gregaria* the rostral cavity is more or less filled with thickened dental lamellæ, and sometimes the incipient growth of a transverse septum is perceptible.

In several of the Spirifers of the Hamilton group the septum is well marked, while in others there is an incipient development of the same character. In *Spirifera granulifera* the upper part of the rostral cavity is filled with shelly matter, and this apparently encroaches upon the space below with the advancing age of the shell. The fissure becomes partially filled, and a thickened plate projects a little in advance of the solid filling of the beak, leaving behind it, or on the inner side, a conical cavity directed towards the apex of the shell. The muscular area is divided by a low longitudinal crest, which, in its extension towards the beak, becomes wider, and is often much thickened towards its junction with the solid shelly matter filling the rostral cavity. Looking at this feature from the apex of the shell, it presents a subconical form, and is more or less abruptly attenuated towards the centre of the muscular impression. This callosity sometimes becomes so prominent as to produce an emargination or indentation in the apex of the cast, and a similar feature is often observed in the casts of other species of SPIRIFERA.

Regarding the *S. granulifera* alone, there is little to attract especial notice, beyond the general fact of a partial filling of the rostral cavity with the exterior portion prolonged between the dental lamellæ, but so much thickened as scarcely to merit the term septum. In *Spirifera marcyi* this development of shelly matter has the character of a true septum, closing one-third or more of the length of the fissure from above, and leaving an open rostral cavity behind it. In *Spirifera medialis* and *S. macronotus* there is a thickened transverse

septum extending from one-third to one-half the length of the fissure from the apex, and this feature is quite independent of the pseudo-deltidium. The rostral cavity lies behind this septum, and may be open or free from the accumulation of shelly matter to a greater or less extent; but it is not uncommon to find nothing more than a thickening of the base of the dental plates and a partial filling of the rostral cavity. This condition changes to a greater or less extent during the growth of the shell; but a partial filling of the fissure at its apex is probably more common than otherwise, particularly in full-grown individuals.

In the Spirifers of the Carboniferous rocks which I have been able to examine, this feature is variably developed. In *S. plena* of the Burlington limestone, the septum extends for more than half the length of the fissure; while it is less developed in *S. grimesi*, and scarcely at all in *S. increbescens* and *S. opima*.

The shell texture of SPIRIFERA is usually regarded as fibrous, and this is true of all those I have examined, though in some of the species of the higher formations I have observed characters which, with imperfect means of investigation, seem to be irregularly distributed ducts penetrating the shell. I have not been able to examine the shell of *Spirifera alta*, to learn whether any changes have taken place in its texture, not observed in other species of SPIRIFERA; but in *S. textus*,* where the septum and tube are developed, the shell is penetrated by numerous pores or ducts which are somewhat coarser than the ordinary punctate structure of some other Brachiopoda; and though not in actual contact, are often arranged in regular order and frequently in close proximity to each other, not essentially differing from that of SPIRIFERINA as given by Dr. CARPENTER. The intermediate spaces have a distinctly and beautifully fibrous or prismatic structure, differing in no respect from ordinary Spirifers or ATHYRIS.

It should be observed, in this connection, that the dental plates, both in *Spirifera alta* and *S. textus*, reach to the bottom of the cavity, and partially surround the muscular impression, which is precisely like that of ordinary Spirifers.

* In this species and in *Spiriferina spinosa* of Norwood & Pratten, the pores or ducts are unequally distributed; being, in some parts of the shell, closely crowded, while in others they are more distant and often following the line of growth, though frequently irregularly disposed.

Prof. Winchell remarks, of the proposed Genus *Syringothyris*, that "the shell is impunctate in all conditions and under high powers."

In these remarks, I have not intended to express an opinion of the generic value of certain characters, but merely to show, as it appears to me, a gradual or successive development in certain parts, which finally becomes so wide a departure from the characters of typical forms of SPIRIFERA, that it deserves especial attention. Nor can we deny that this progressive development of the septum and its modifications keeps pace and corresponds with the geological succession; reaching its extreme state, so far as now known, in the Carboniferous period.

In our investigations of the Chemung group in its more easterly extension in the State of New York, it has proved, throughout the greater part of its thickness, to be comparatively barren of animal organisms, though often containing an abundance of the remains of land vegetation. As we progress westerly, the coarser sediments have given place to finer materials, or are more or less intercalated with shales or shaly and calcareous beds, while the coarser beds exhibit less resemblance to shore deposits, and we find an increasing number of animal remains both of the Brachiopoda and Lamellibranchiata, though there are usually few of any other class. But these are not equally distributed, either vertically or horizontally.

There is one fact, however, which can scarcely fail to impress the collector of fossils in this group of strata, which is, that in going westward, certain forms which are abundant in some localities become rare or disappear altogether, so that sometimes localities not very far removed from each other give almost entirely a different set of species. Certain species which are common in Schoharie, Broome, Tioga and Chemung Counties, I have not seen in Cattaraugus and Chautauque Counties; while many species which are common in the western counties are quite rare or unknown to me in Tioga, Tompkins, and the counties east of these. Although we may attribute this view in some part to our imperfect collections, it is nevertheless in a great degree true.

Reasoning upon the nature and origin of the sediments as well as upon these observed conditions, we might expect to find a changing fauna as we recede from the ancient coast line furnishing these materials, and which were then swept into the wide ocean to the westward. While in some of the more eastern localities we find species of the Hamilton group apparently mingling with those of the Chemung group, the higher beds of Cattaraugus and Chautauque Counties give us an association of fossils having a more carboniferous

aspect than those of the higher beds in the eastern counties of the State.

Besides the contemporaneity of the sedimentary formations holding dissimilar species in distant localities, we have to regard the gradual lithological changes affecting the character of the fauna in the same continuous deposition. There can be no longer any question that the higher arenaceous and argillaceous formations of New York and the adjacent portions of Pennsylvania, when traced in a southwesterly direction, become intercalated with calcareous bands, gradually giving out and becoming replaced in a great degree by calcareous or argillo-calcareous deposits in which some of the same species of fossils continue, while there is an accession of other forms adapted to the changed conditions of life.* In the extreme southwestern extension of the Palæozoic series the interval between the Upper Helderberg group and the coal measures, which in the north is occupied by the Hamilton, Portage, Chemung, and Catskill formations, which constitute so marked a feature in New York, Pennsylvania, and Ohio, is there filled almost exclusively by calcareous accumulations, but we can scarcely suppose that the lapse of time required for the deposition of the northern sedimentary formations remained unrecorded by a fauna of some kind while the interval is filled by an accumulation of a thousand or more feet of calcareous formation.

It here becomes a matter of great interest to decide what shall constitute the *fauna Devonian*, and what may be regarded as the *fauna Carboniferous*. Looking at the great number of *Productus* (for although I have used the term *Productella* as indicating certain distinctions, the fossils are in all essential respects *Productus*) in the central and western portions of the State, they alone would give a Carboniferous aspect to the fauna. But when we find *Spirifera disjuncta*, and other fossils of acknowledged Devonian age, we instinctively allow less than the due importance to the Carboniferous evidence. Nevertheless we are forced to admit, even within the State of New York, a gradual diminution of the Devonian types, and an augmentation of the Carboniferous types, in the same beds as we go westward. And finally, we have every reason to believe that in those

* I have already shown a similar condition existing at the period of the coal measures, where some calcareous bands of a few feet in thickness in Ohio, Pennsylvania, and Virginia, become expanded, so that together with the associated calcareous shales they embrace almost the entire formation towards the Rocky Mountains and Mexico in the far western and southwestern regions of the United States.

sedimentary formations, between the Hamilton group and the Coal measures in the east, and between the same group and the Burlington (Carboniferous) limestone in the west, the Devonian aspect of the fauna on the one hand, and its Carboniferous aspect on the other, are due in a great degree to geographical and physical conditions, and not to difference in age or chronological sequence of the beds containing the fossils.

This view of the case, which is consonant with the facts observed, will account for the coming in of forms which we term Carboniferous, as we pursue our investigations to the westward.

The same opinions seem gradually to be obtaining ground in Great Britain, but the idea is not new with me. It is now about fifteen years since I expressed similar opinions in a review and comparison of the Palæozoic groups and systems of Europe and America.*

In some of the concluding paragraphs of this chapter, after having made a comparison of the species cited as common to the Silurian and Devonian and to the latter and the Carboniferous system, I have said :

“The arenaceous and argillaceous deposits, which we trace uninterruptedly over so wide an area, and which present to us such gradual and almost imperceptible changes in the fauna when studied continuously, would, if broken up and isolated so that they could not be traced consecutively, present the same phases which are exhibited by the systems in Europe to which they are related. From all these facts there seems to be but one conclusion, and that is, in the British Islands particularly, either there are remarkable exceptions to the general law in the continuation of species from one to another, or that there is no foundation for a distinction between the Devonian and Carboniferous systems.”

NOTE.—The *Spirifera alta* referred to in the preceding pages is an analogue of the European carboniferous *Spirifera cuspidata*, having a similar elevated area which is usually “slightly inclining forward or nearly rectangular to the general plane of the dorsal valve. The fissure is high and narrow, and is closed for two-thirds of its length from the apex by a concave septum which is entirely independent of the pseudo-deltidium.” On page 249 of vol. iv, Pal. N. Y., I have made the following remarks under the description of the species :

* In Foster and Whitney's Report, chap. xxiii, pp. 285-318.

"This species is known to me only in the condition of casts of the interior, and its usual appearance is illustrated in the figures on Plate xliii. Its general aspect is much like that of the European *Spirifer cuspidata*, Martin; but there are important differences by which it may be distinguished: these are, the plications on the mesial fold, the larger area of the dorsal valve, and the shorter extension and greater divergence of the dental lamellæ by the sides of the muscular impression. Some of these characters, I conceive, are not likely to change to those shown by *S. cuspidata*. In the concave septum closing two-thirds of the fissure from above, it resembles that species as described by Prof. McCoy, who mentions the presence of a 'deep-seated pseudo-deltidium.'* In one of the figures given by Mr. Davidson and referred with doubt to this species,† the cast shows a tubular perforation in the filling of the fissure; and a gutta percha impression from the same shows the mark of a foramen, but there is no positive evidence of a septum, which is so conspicuous in our specimens, and which I suppose to be the feature characterized by Prof. McCoy as a deep-seated pseudo-deltidium. In our species I have not been able to discover any corresponding perforation; the only indication of this being the semi-cylindrical impression along the centre of the fissure (in the cast), showing a callosity of the septum behind the exterior wall.

"In form and proportions, this species bears a very close resemblance to one in the Waverly sandstone of Ohio, and also to one in the fine-grained sandstone of Burlington, Iowa; but of neither of these have I the necessary material for satisfactory comparison. It differs from the *S. subcuspidata*‡ of Schnur in the plications of the mesial fold and sinus, and the wider area of the dorsal valve; and also in the same characters it differs from the *S. textus* of the sandstone and argillaceous limestone near New Albany, Indiana."§

* . . . ; triangular opening very large, often displaying the internal deep-seated pseudo-deltidium (without perforation, leaving the only opening to the shell at its base); . . . McCoy, British Palæozoic Fossils, p 426.

† Monograph of British Carboniferous Brachiopoda, Plate ix, f. 1 & 1 a.

‡ *Spirifer subcuspidatus*, Hall, Geological Report of Iowa, p. 646, pl. xx, f. 6, is a distinct species, and apparently identical with *S. textus*, Hall, Tenth Report on the State Cabinet, p. 160: 1857. See Nineteenth Report on the State Cabinet, for remarks on this species.

§ The latter species before alluded to as a punctate shell has the fissure partially closed by a septum, and this is perforated near its apex by a circular foramen, which is continued in a longitudinal tube behind the septum and opens into the cavity of the shell below. The margins of the fissure are grooved for the reception of a pseudo-deltidium as in ordinary spirifers, and this appendage is partially preserved in some of my specimens.